10/572692
IAP9 Rec'd PCT/PTO 20 MAR 2006
[10191/4309]

METHOD AND DEVICE FOR CONTROLLING A RADIATION SOURCE

Field Of The Invention

The present invention relates to a method and a device for controlling a radiation source, in particular a light source, preferably in a motor vehicle, as well as its use in a system, in particular in a night vision system in a motor vehicle.

Background Information

German Patent No. 40 32 927 describes a device for improving the visibility in a motor vehicle. An image captured by an infrared-sensitive camera is visually superimposed, as a virtual image, on the outside landscape using a display device designed as a head-up display and is displayed to the driver. Furthermore, at least one radiation source having an infrared radiation component is provided for illuminating the visual range viewed by the driver in the direction of travel.

Night vision systems (NV systems) of this type, such as described in German Patent No. 40 32 927, based on light having wavelengths in the near infrared (NIR) range, illuminate the scene in front of a motor vehicle using infrared headlights (NIR headlights), usually having high beam characteristics. Under certain conditions, NIR radiation, which is not visible to humans and most animals, may affect the eyes of humans and animals that are within the effective range of such NIR headlights. To prevent such negative effects, it is conceivable to derive minimum distances for certain radiation intensities between NIR headlights and eyes, which are to be observed and are ensured by design measures, for example.

In addition to design measures, German Published Patent Application No.101 26 492, for example, describes an alternative method to ensure that traffic participants are affected by NIR light. A method is proposed in which laser light having a wavelength outside the visible spectrum is only emitted when the vehicle is in motion. Furthermore, a method is known whereby NIR headlights are not activated until a minimum velocity, for example 30 km/h, is reached. The disadvantage of these methods is that the night view function of a night vision system is not available when the vehicle is at a standstill or is moving slowly, although even in those cases there may be situations where the night view function is useful. For example, a

night view function would be useful when driving slowly on unpaved roads or narrow streets. Furthermore, the service life of NIR headlights is negatively affected by them being frequently switched on and off. Stop-and-go situations and/or driving situations in the proximity of the minimum velocity place a heavy load on NIR headlights in particular. This may result in the acceptance of such night vision systems by users being reduced due to this limited availability.

Summary Of The Invention

By switching off the radiation source or reducing its intensity when approaching an object, risk to humans due to radiation sources in the non-visible wavelength range is effectively counteracted.

It is particularly advantageous that it may be reliably detected that an object is being approached with the help of distance-measuring sensors, at least some of which are already present in vehicles nowadays, allowing the radiation source to be turned off or its intensity reduced or diminished as a function of the distance.

All in all, a procedure for improving the visibility in a motor vehicle is thus achieved without negative effects and with a high degree of availability. In a particularly advantageous manner, the method contributes to reducing the negative effects, in particular the negative effects on the eyes, in humans such as pedestrians and/or cyclists and/or automobile drivers and/or animals by non-visible radiation outside the visible spectrum.

The use of the procedure described below is advantageous in particular in night vision systems in motor vehicles in which a video sensor that is sensitive at least in the visible spectral range, in particular in the near infrared spectral range, captures the surroundings of the motor vehicle, and this information is displayed to the driver. The night vision system is only deactivated by the method described below if the sensors detect objects and/or these objects are at a minimum distance from the radiation source. This contributes, in a particularly advantageous manner, to increasing the service life and availability of the light sources used, in particular of the headlights operating in the near infrared range (NIR headlights).

It is particularly advantageous that at least one short-range sensor (e.g., an ultrasound sensor), preferably of a system already installed in the vehicle (e.g., of a parking aid) and/or at least

one radar sensor is used for distance measurement. The use of such sensors already used in the vehicle for other functions involves only a slight additional cost, since no additional hardware is required.

The distance-regulated (distance to the object) setting of the intensity of the radiation source is advantageous. A setting that is proportional to the distance is advantageous. Furthermore, fully switching off the radiation source below a minimum distance (e.g., 20 cm) is advantageous.

A warning to the driver and/or to the at least one object present by an acoustic and/or visual warning signal, when it is recognized that an object is being approached, is advantageous in particular.

Brief Description Of The Drawings

Figure 1 shows a block diagram of the preferred exemplary embodiment.

Figure 2 shows the arrangement of the sensors in a motor vehicle in the preferred exemplary embodiment.

Figure 3 shows a flow chart of the method of the preferred exemplary embodiment.

Detailed Description

A method, a device and a processing unit for improving the visibility in a motor vehicle is described below, a radiation source of the motor vehicle illuminating an illumination range. At least one surveillance sensor of the motor vehicle monitors the surroundings of the vehicle for the presence of objects. In the preferred exemplary embodiment, the radiation source is a light source, for example, the headlight of a vehicle.

In the preferred exemplary embodiment, the space in front of two NIR headlights of a night vision system is monitored by sensors. These are used to detect people and other objects in front of the NIR headlights, in particular distance to the NIR headlights, and when the distance drops below the minimum distance, the NIR headlights are de-activated. As an alternative to de-activation of both NIR headlights, only one headlight may be de-activated, so that the night view function of the night vision system remains available at least to a reduced degree.

As an alternative to de-activation of at least one NIR headlight, in a variant of the preferred exemplary embodiment, the radiation intensity of the NIR headlight is reduced; in a preferred embodiment it is regulated as a function of the distance. In one embodiment, this is accomplished by the existence of an approximately proportional relationship between distance and intensity in at least one distance value range.

In one embodiment, the radiation source is switched off for distance values to the object below a certain value (in the case of dangerous limiting distances, e.g., distances smaller than 20 cm).

In one embodiment, a warning (visual, acoustic, and/or haptic) is provided to the driver and/or the object.

In the preferred exemplary embodiment, distance-measuring sensors are used, which are already present in the vehicle or whose use in the vehicle is at least known. These are, for example, ultrasound-based park pilot sensors (PP sensors), long-range 77 GHz radar sensors such as used for ACC (adaptive cruise control), short-range 24 GHz radar sensors, or LIDAR sensors.

In one embodiment, not only the distance to the object, but also the approach to an object is recognized from the distance signal and/or its variation. When approaching an object has been recognized, the above measures are implemented individually or in any desired combination.

The above-described procedure is suitable for all visibility-supporting systems having radiation sources outside the visible range for automobiles or other applications, for example, in measuring systems in manufacturing and process technology. In particular, the procedure is suitable for night vision systems for motor vehicles in the forward as well as in the reverse direction of travel (backing-up camera and diode tail lights).

Figure 1 shows a block diagram of the preferred exemplary embodiment which includes sensors 10, 12, 14, a processing unit 16, and NIR headlights 18. Sensors 10, 12, 14 are situated, as explained below with reference to Figure 2, on a motor vehicle. In the preferred exemplary embodiment, four ultrasound sensors 10 are used as sensors 10, 12, 14. Alternatively or additionally, a radar sensor 12 and/or a video sensor 14 are shown. Sensors

10 monitor the illumination range of NIR headlights 18 fully, at least in its width. In the preferred exemplary embodiment, video sensor 14 and NIR headlights 18 are components of a night vision system which is supplemented by a display device for displaying information of video sensor 14 to the driver. In the preferred exemplary embodiment, a CMOS video camera is used; alternatively or additionally, a CCD video camera may be used in one variant. For the night view function, the spectral range above the visible spectrum (380 nm – 780 nm) and within the sensitivity range of CCD or CMOS video cameras (approximately 350 nm – 1100 nm because of the spectral sensitivity of silicon), i.e., between 780 nm and 1100 nm, is relevant in particular. Because of the sensitivity range of the video camera, NIR IR-A in particular is therefore relevant for the night view function. In principle, any radiation source whose spectral range contains at least the NIR IR-A range or portions thereof may be used. In the preferred exemplary embodiment, headlights having halogen bulbs with a color temperature between 3200 K and 3400 K, whose spectral range is limited by interference filters or absorption filters to the near infrared range between approximately 780 nm and 1200 nm are used as NIR headlights 18. In one variant of the preferred exemplary embodiment, laser headlights are used as NIR headlights 18. In a further variant, an array of light-emitting diodes (LEDs) is used as NIR headlights 18, also in conjunction with tail lights of the vehicle. In the presence of one or more objects, the sensors generate sensor signals which are transmitted via signal lines 20 to processing unit 16. Processing unit 16 contains a plurality of function modules 40, 42, 44, 46 shown in Figure 3. Function modules 40, 42, 44, 46 are implemented as programs and/or program steps of at least one microprocessor in processing unit 16 and/or via programmable logic, in particular as ASIC and/or FPGA. Processing unit 16 generates setting signals of NIR headlights 18, which are transmitted via signal lines 20, the radiation intensity and/or the function of the headlight being regulated and/or controlled. The sensor data and control data is transmitted via signal lines 20 electrically and/or optically and/or by wireless transmission, signal lines 20 being a single-wire line and/or a 2-wire line and/or a multiwire line. In particular, signal lines 20 are designed alternatively or additionally as a bus line such as a CAN bus, or the signals are modulated onto the supply lines via power line communication.

Figure 2 shows the arrangement of sensors 10, 12, 14 and their monitoring ranges 26, 28, 30 in front of a motor vehicle 22 in the preferred exemplary embodiment. Figure 2 shows a top view onto motor vehicle 22 which in the figure is traveling to the left. The two NIR

headlights 18 are mounted in the area of the headlights for high beam and low beam and/or in the area of the additional headlights and/or in the area of the fog lights on the front of vehicle 22 in such a way that illumination ranges 32 in the direction of travel essentially correspond to the illumination range of the high-beam headlight. Furthermore, radar sensor 12 is mounted in the area of the radiator grill and/or of the front bumper of vehicle 22. Alternatively or additionally to radar sensor 12, a LIDAR sensor is used in one variant of the preferred exemplary embodiment. Monitoring range 30 of radar sensor 12 and/or of the LIDAR sensor has an aperture of approximately 15° to 20°. Monitoring range 30 begins at approximately 2 meters in front of the sensor. Alternatively or additionally, scanning radar or LIDAR principles are used in a further variant. In these two sensor types, monitoring range 30 is extended accordingly by the scanning angle which is not shown in Figure 2. In the preferred exemplary embodiment, video sensor 14 is mounted on the inside of windshield pane 24 of vehicle 22. In addition to its monitoring function, video sensor 14 is also a component of the night vision system of the vehicle. Video sensor 14 is mounted inside vehicle 22 in the area of the rear-view mirror, the optical axis of video sensor 14 for covering the traffic area being oriented in such a way that monitoring range 26 of video sensor 14 approximately covers illumination range 32 of NIR headlights 18 in front of vehicle 22 in the direction of travel. Monitoring range 26 of video sensor 14 has an aperture in the direction of travel of approximately 30°, thus matching the aperture of NIR headlights 18, which is also approximately 30°. Depth sharpness range and thus monitoring range 26 of video sensor 14 begins at approximately 2 meters in front of video sensor 14. Furthermore, Figure 2 shows a cluster of four ultrasound sensors 10, which are distributed symmetrically on the front bumper of vehicle 22. Ultrasound sensors 10 are used in their function as park pilot sensors to support the driver in parking. Alternatively, a cluster of six ultrasound sensors 10 are used in one variant. Monitoring range 28 of ultrasound sensors 10 covers a range of between approximately two and five meters, preferably two meters, around the front bumper of motor vehicle 22 in the direction of travel. The cluster covers the entire space in front of NIR headlights 18. Monitoring ranges 28, 30, 32 of sensors 10, 12, 14 clearly show that the ranges are detected directly in front of headlights 18, in the preferred exemplary embodiment by at least two sensor types, namely the cluster of ultrasound sensors 10 and video sensor 14. This contributes to great detection reliability of objects.

Figure 3 shows a flow chart of the method for improving the visibility in a motor vehicle of the preferred exemplary embodiment, having function module 40. This Figure 3 illustrates the signal processing structure for monitoring the NIR headlights. The ultrasound sensors deliver sensor signals 52, preferably distance values to the objects. This data 52 is transmitted to function module 40, where the distance value is compared to a threshold value. If the distance value is less than a critical limiting distance (e.g., 20 cm), a control signal (70, 72) is generated, which turns off the headlight(s). If the value is greater than the limiting value, it is derived from at least one previous value whether the vehicle is approaching the object, i.e., whether the distance is decreasing. Alternatively, the fact that the limiting value has been exceeded is sufficient. If this is the case, a control signal is generated for the headlight(s) on the basis of a regulation for the radiation intensity of the headlight. The radiation intensity is then preferably set proportional to the distance to the object, the radiation intensity being reduced as the object is being approached. Alternatively, the radiation intensity is regulated as a function of the approach, an approximate proportionality being aimed at also in this case. The faster the object is being approached, the lower the radiation intensity. A combination of the two approaches is also part of an embodiment.

The above-described method and/or the method are not limited to use in a night vision system having NIR headlights. Rather, the method and/or the device and/or the processing unit are also usable, in addition to night view functions, in other automobile functions operating with light having wavelengths outside the visible spectrum, for example, in infrared light-based communication between two motor vehicles. Alternatively or additionally, radiation sources emitting light having wavelengths in the ultraviolet (UV) spectrum are monitored.

In a further variant, the above-described method and/or the device and/or the processing unit is used in the rear area of the vehicle, for example, in an infrared-based backing-up camera and diode tail lights.

In a further variant of the preferred exemplary embodiment, alternatively or additionally, a warning is issued for the at least one object present by an acoustic and/or visual warning signal.

The driver may be warned via visual, acoustic, and/or haptic actuators.